EXHIBIT 1

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United States Patent [19]

Yamagishi et al.

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[54] THREE-PIECE SOLID GOLF BALL

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[30] Foreign Application Priority Data

Mar. 11, 1996 [JP] Japan 8-082121

[51] Int. Cl.^{6} A63B 37/06; A63B 37/12; A63B 37/14

[52] U.S. Cl. 473/374; 473/373

[58] Field of Search 473/373, 374, 473/378, 384

[56] References Cited

U.S. PATENT DOCUMENTS

4,431,193	2/1984	Nesbitt	473/374
5,048,838	9/1991	Chikaraishi	473/373 X
5,273,286	12/1993	Sun	473/376 X
5,439,227	8/1995	Egashira et al.	473/377 X
5,601,503	2/1997	Yamagishi et al.	473/351 X
5,688,191	11/1997	Cavallaro et al.	473/373

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[57] ABSTRACT

The invention provides a three-piece solid golf ball featuring an increased flight distance on driver shots and improved control on approach shots. In a three-piece solid golf ball consisting of a solid core, an intermediate layer, and a cover, provided that hardness is measured by a JIS-C scale hardness meter, the core center hardness is up to 75 degrees, the core surface hardness is up to 85 degrees, the core surface hardness is higher than the core center hardness by 8 to 20 degrees, the intermediate layer hardness is higher than the core surface hardness by at least 5 degrees, and the cover hardness is lower than the intermediate layer hardness by at least 5 degrees.

6 Claims, 2 Drawing Sheets

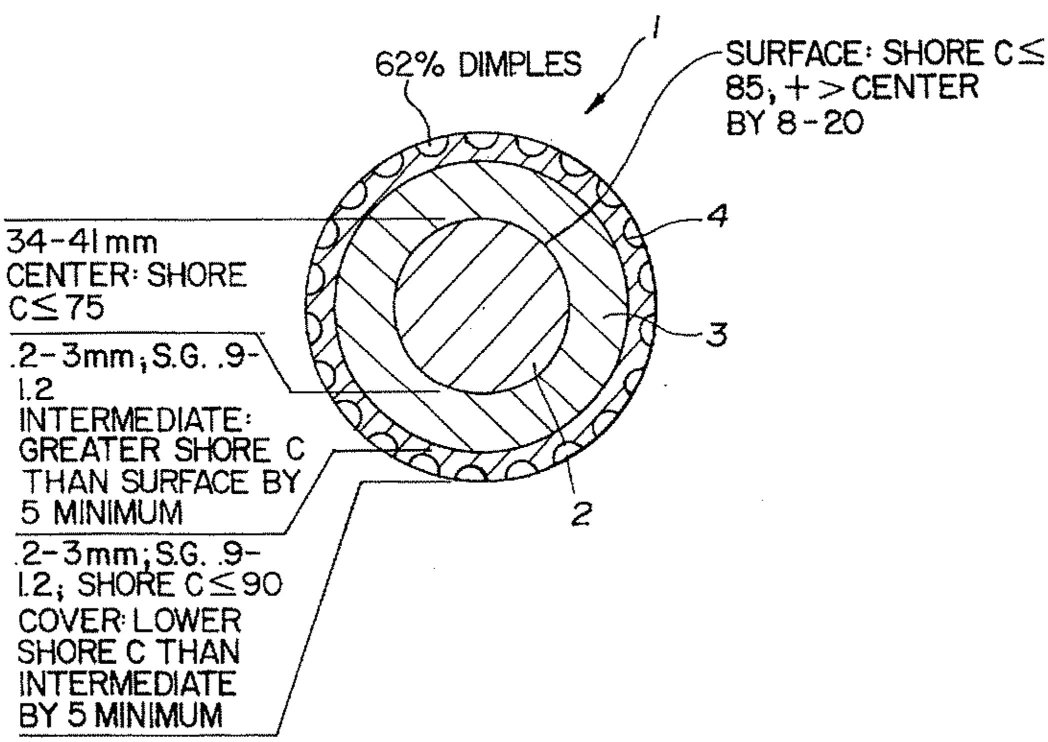


FIG.1

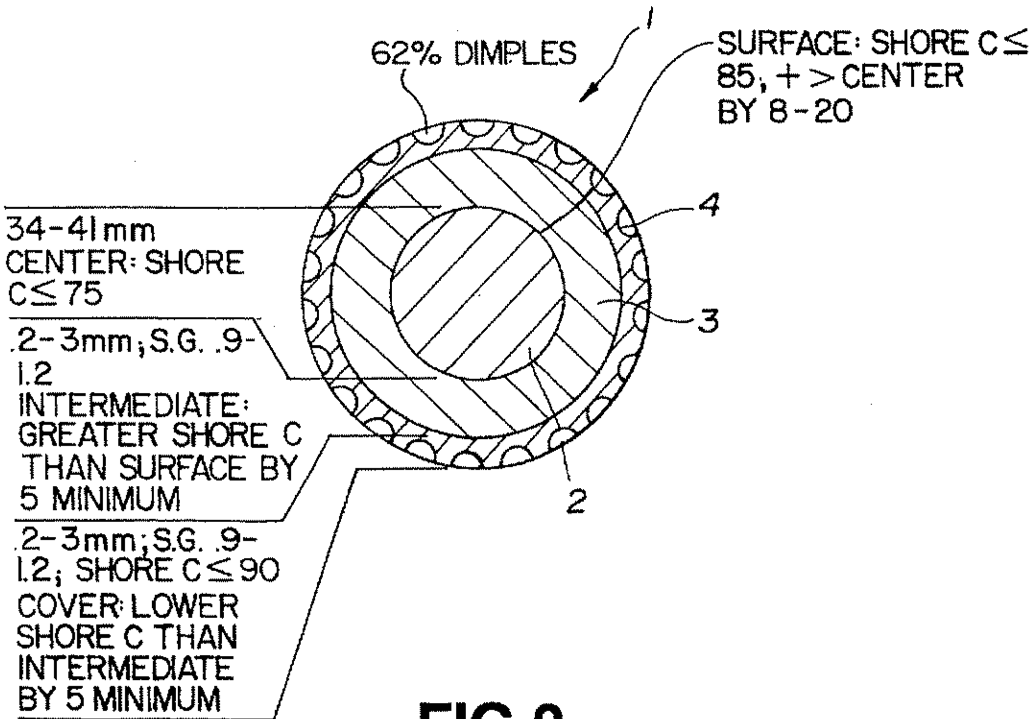
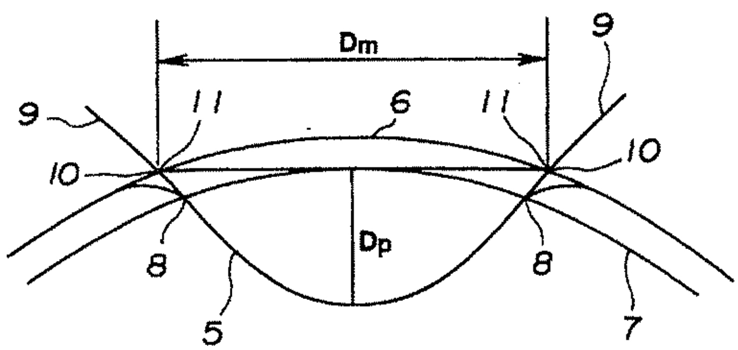

62% DIMPLES
1
SURFACE: SHORE C≤ 85; + > CENTER BY 8-20
4
3
2
34-41mm CENTER: SHORE C≤75
.2-3mm; S.G. .9-1.2 INTERMEDIATE: GREATER SHORE C THAN SURFACE BY 5 MINIMUM
.2-3mm; S.G. .9-1.2; SHORE C≤90 COVER: LOWER SHORE C THAN INTERMEDIATE BY 5 MINIMUM

FIG.2


Dm
9
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Dp
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FIG.3

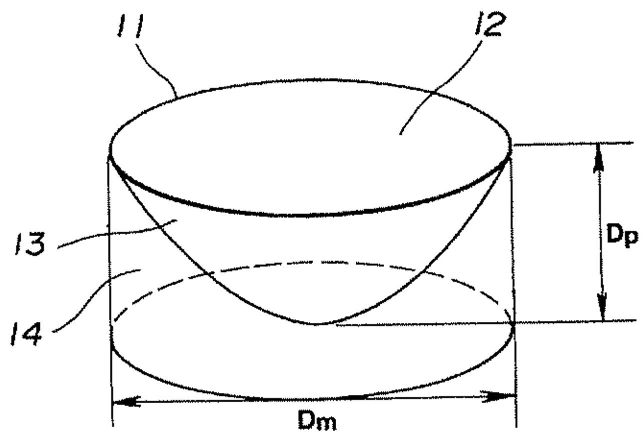
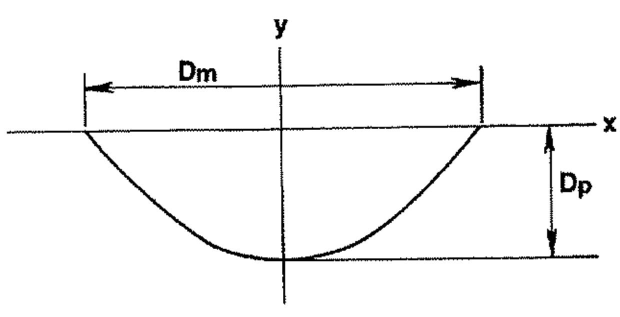


FIG.4



THREE-PIECE SOLID GOLF BALL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a three-piece solid golf ball of the three-layer structure comprising a solid core, an intermediate layer, and a cover and more particularly, to such a three-piece solid golf ball which features an increased flight distance on full shots with a driver and improved control on approach shots with No. 5 iron or sand wedge.

2. Prior Art

From the past, two-piece solid golf balls consisting of a solid core and a cover are used by many golfers because of their flight distance and durability features. In general, two-piece solid golf balls give hard hitting feel as compared with wound golf balls, and are inferior in feel and control due to quick separation from the club head. For this reason, many professional golfers and skilled amateur golfers who prefer feel and control use wound golf balls rather than two-piece solid golf balls. The wound golf balls are, however, inferior in carry and durability to the solid golf balls.

More particularly, when two-piece solid golf balls are subject to full shots with a club having a relatively large loft angle, the ball flight is mainly governed by the club loft rather than the ball itself so that spin acts on most balls to prevent the balls from too much rolling. However, on approach shots over a short distance of 30 to 50 yards, rolling or control substantially differs among balls. The major cause of this difference is not related to the basic structure of the ball, but to the cover material. Then some two-piece solid golf balls use a cover of a relatively soft material in order to improve control on approach shots, but at the sacrifice of flight distance.

Controllability is also needed on full shots with a driver. If a soft cover is used as a result of considering too much the purpose of improving spin properties upon control shots such as approach shots with No. 5 iron and sand wedge, hitting the ball with a driver, which falls within an increased deformation region, will impart too much spin so that the ball may fly too high, resulting in a rather reduced flight distance. On the other hand, if the spin rate is too low, there arises a problem that the ball on the descending course will prematurely drop, adversely affecting the ultimate flight distance too. As a consequence, an appropriate spin rate is still necessary upon driver shots.

Anyway, the prior art two-piece solid golf balls fail to fully meet the contradictory demands of players, the satisfactory flight performance that the ball acquires an adequate spin rate upon full shots with a driver and the ease of control that the ball acquires a high spin rate upon approach shots with No. 5 iron and sand wedge.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a three-piece solid golf ball which features an increased flight distance on full shots with a driver and improved control on approach shots with No. 5 iron or sand wedge.

Making extensive investigations on a three-piece solid golf ball of the three-layer structure comprising a solid core, an intermediate layer, and a cover, we have found that the above object is attained by optimizing the hardness distribution of the core, forming a hard intermediate layer between the core and the soft cover, and adjusting a percent dimple surface occupation. By virtue of the synergistic effect of these factors, the resulting golf ball travels an increased flight distance on full shots with a driver and is well controllable on approach shots with No. 5 iron or sand wedge.

More specifically, we have found that the following advantages are obtained in a three-piece solid golf ball of the three-layer structure comprising a solid core, an intermediate layer, and a cover. when the solid core, intermediate layer, and cover each have a hardness as measured by a JIS-C scale hardness meter, the core center hardness is up to 75 degrees, the core surface hardness is up to 85 degrees, the core surface hardness is higher than the core center hardness by 8 to 20 degrees, the intermediate layer hardness is higher than the core surface hardness by at least 5 degrees, and the cover hardness is lower than the intermediate layer hardness by at least 5 degrees. Upon deformation in an increased deformation region (associated with full shots with a driver), the presence of a hard intermediate layer between a soft deformable cover and a soft core ensuring soft feel is effective for reducing the energy loss by excessive deformation of the core and thereby enabling to form a structure of efficient restitution while maintaining the softness of the ball as a whole. Then the ball will travel an increased flight distance upon full shots with a driver. Although a soft cover is used, the ball gains an appropriate spin rate and is free of shortage of flight distance. At the same time, in a reduced deformation region (associated with approach shots), the ball gains an increased spin rate and is well controllable. Additionally, by adjusting dimples such that the percent surface occupation of dimples in the cover surface is at least 62% and an index (Dst) of overall dimple surface area is at least 4, and optimizing the dimple pattern, the flight properties (flight distance and flight-in-wind) of the golf ball are further enhanced. By virtue of the synergistic effect of these factors, the resulting golf ball covers an increased flight distance on full shots with a driver and is well controllable on approach shots with No. 5 iron or sand wedge, that is, satisfies the contradictory demands of players.

Therefore, according to the present invention, there is provided a three-piece solid golf ball of the three-layer structure comprising a solid core, an intermediate layer, and a cover, having a plurality of dimples in the ball surface. Provided that the solid core at its surface and center, the intermediate layer, and the cover each have a hardness as measured by a JIS-C scale hardness meter, the core center hardness is up to 75 degrees, the core surface hardness is up to 85 degrees, the core surface hardness is higher than the core center hardness by 8 to 20 degrees, the intermediate layer hardness is higher than the core surface hardness by at least 5 degrees, and the cover hardness is lower than the intermediate layer hardness by at least 5 degrees. The dimples occupy at least 62% of the ball surface.

In one preferred embodiment, the dimples in the ball surface total in number to 360 to 450 and include at least two types of dimples having different diameters. An index (Dst) of overall dimple surface area given by the following expression (1) is at least 4.

$$Dst = \frac{n \sum_{k-1}^{n} [(Dmk^2 + Dpk^2) x V_0 k x Nk]}{4R^2} \tag{1}$$

wherein R is a ball radius, n is the number of dimple types, Dmk is a diameter of dimples k, Dpk is a depth of dimples k, Nk is the number of dimples k wherein k=1, 2, 3, . . . n, and V_0 is the volume of the dimple space below a plane circumscribed by the dimple edge divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross-sectional view of a three-piece solid golf ball according to one embodiment of the invention.

FIG. 2 is a schematic cross-sectional view of a dimple illustrating how to calculate V_0.

FIG. 3 is a perspective view of the same dimple.

FIG. 4 is a cross-sectional view of the same dimple.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a three-piece solid golf ball 1 according to the invention is illustrated as comprising a solid core 2 having an optimized hardness distribution, a hard intermediate layer 3, and a soft cover 4.

In the golf ball 1 of the invention, the hardness distribution of the solid core 2 is optimized. More particularly, the core 2 is formed to have a center hardness of up to 75 degrees, preferably 60 to 73 degrees, more preferably 63 to 69 degrees as measured by a JIS-C scale hardness meter. The core 2 is also formed to have a surface hardness of up to 85 degrees, preferably 70 to 83 degrees, more preferably 73 to 80 degrees. If the core center hardness exceeds 75 degrees and the surface hardness exceeds 85 degrees, the hitting feel becomes hard, contradicting the object of the invention. It is noted that the hardness referred to herein is JIS-C scale hardness unless otherwise stated.

The core is formed herein such that the surface hardness is higher than the center hardness by 8 to 20 degrees, preferably 10 to 18 degrees. A hardness difference of less than 8 degrees would result in a hard hitting feel provided that the ball hardness and the core surface hardness are fixed. A hardness difference of more than 20 degrees would fail to provide sufficient restitution provided that the ball hardness and the core surface hardness are fixed. The hardness distribution establishing such a hardness difference between the surface and the center of the core ensures that the core surface formed harder than the core center is effective for preventing excessive deformation of the core and efficiently converting distortion energy into reaction energy when the ball is deformed upon impact. Additionally, a pleasant feeling is obtainable from the core center softer than the core surface.

The hardness distribution of the solid core is not limited insofar as the core is formed such that the core surface is harder than the core center by 8 to 20 degrees. It is preferable from the standpoint of efficient energy transfer that the core is formed such that the core becomes gradually softer from its surface toward its center.

The solid core preferably has a diameter of 34 to 41 mm, especially 34.5 to 40 mm. No particular limit is imposed on the overall hardness, weight and specific gravity of the core and they are suitably adjusted insofar as the objects of the invention are attainable. Usually, the core has an overall hardness corresponding to a distortion of 2.5 to 4.5 mm, especially 2.8 to 4 mm under a load of 100 kg applied, and a weight of 20 to 40 grams, especially 23 to 37 grams.

In the practice of the invention, no particular limit is imposed on the core-forming composition from which the solid core is formed. The solid core may be formed using a base rubber, a crosslinking agent, a co-crosslinking agent, and an inert filler as used in the formation of conventional solid cores. The base rubber used herein may be natural rubber and/or synthetic rubber conventionally used in solid golf balls although 1,4-cis-polybutadiene having at least 40% of cis-structure is especially preferred in the invention. The polybutadiene may be blended with a suitable amount of natural rubber, polyisoprene rubber, styrenebutadiene rubber or the like if desired. The crosslinking agent includes organic peroxides such as dicumyl peroxide, di-t-butyl peroxide, and 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane, with a blend of dicumyl peroxide and 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane being preferred. In order to form a solid core so as to have the above-defined hardness distribution, it is preferable to use a blend of dicumyl peroxide and 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane as the crosslinking agent and the step of vulcanizing at 160° C. for 20 minutes. It is noted that the amount of the crosslinking agent blended is suitably determined although it is usually about 0.5 to 3 parts by weight per 100 parts by weight of the base rubber. The co-crosslinking agent used herein is not critical. Examples include metal salts of unsaturated fatty acids, inter alia, zinc and magnesium salts of unsaturated fatty acids having 3 to 8 carbon atoms (e.g., acrylic acid and methacrylic acid), with zinc acrylate being especially preferred. Examples of the inert filler include zinc oxide, barium sulfate, silica, calcium carbonate, and zinc carbonate, with zinc oxide and barium sulfate being often used. The amount of the filler blended is usually up to 40 parts by weight per 100 parts by weight of the base rubber although the amount largely varies with the specific gravity of the core and cover, the standard weight of the ball, and other factors and is not critical. In the practice of the invention, the overall hardness and weight of the core can be adjusted to optimum values by properly adjusting the amounts of the crosslinking agent and filler (typically zinc oxide and barium sulfate) blended.

The core-forming composition obtained by blending the above-mentioned components is generally milled in a conventional mixer such as a Banbury mixer and roll mill, compression or injection molded in a core mold, and then heat cured under the above-mentioned temperature condition, whereby a solid core having an optimum hardness distribution is obtainable.

The intermediate layer 3 enclosing the core 2 is preferably formed to a JIS-C hardness of 75 to 100 degrees, more preferably 80 to 98 degrees. The intermediate layer is formed to a hardness higher than the core surface hardness by at least 5 degrees, preferably 5 to 20 degrees, more preferably by 7 to 18 degrees. A hardness difference of less than 5 degrees would fail to provide sufficient restitution whereas a hardness difference of more than 20 degrees would result in a dull and rather hard hitting feel. The restitution of the core can be maintained by forming the intermediate layer to a higher hardness than the core surface hardness.

The gage, specific gravity and other parameters of the intermediate layer may be properly adjusted insofar as the objects of the invention are attainable. Preferably the gage is 0.2 to 3 mm, especially 0.7 to 2.3 mm and the specific gravity is 0.9 to less than 1.2, especially 0.94 to 1.15.

Since the intermediate layer 3 serves to compensate for a loss of restitution of the solid core which is formed soft, it is formed of a material having improved restitution insofar as a hardness within the above-defined range is achievable. Use is preferably made of a blend of ionomer resins such as Himilan (manufactured by Mitsui-duPont Polychemical K.K.) and Surlyn (E.I. duPont) as will be described later in Table 2. An intermediate layer-forming composition may be obtained by adding to the ionomer resin, additives, for example, an inorganic filler such as zinc oxide and barium sulfate as a weight adjuster and a coloring agent such as titanium dioxide.

The cover 4 enclosing the intermediate layer 3 must be formed to a lower hardness than the intermediate layer. That is, the cover has a hardness lower than the intermediate layer hardness by at least 5 degrees. Additionally, the cover is preferably formed to a JIS-C hardness of up to 90 degrees, more preferably 70 to 90 degrees, most preferably 75 to 87 degrees when spin properties in an approach range are of much account. A cover hardness in excess of 90 degrees on JIS-C scale would adversely affect the spin properties in an approach range so that professional and skilled amateur players who prefer accurate control reject use in the game. A cover hardness of less than 70 degrees would result in a ball losing restitution.

The gage, specific gravity and other parameters of the cover may be properly adjusted insofar as the objects of the invention are attainable. Preferably the gage is 0.2 to 3 mm, especially 0.7 to 2.3 mm and the specific gravity is 0.9 to less than 1.2, especially 0.93 to 1.15. The gage of the intermediate layer and cover combined is preferably 2 to 4.5 mm, especially 2.2 to 4.2 mm.

The cover composition is not critical and the cover may be formed of any of well-known stock materials having appropriate properties as golf ball cover stocks. For example, ionomer resins, polyester elastomers, and polyamide elastomers may be used alone or in admixture with urethane resins and ethylene-vinyl acetate copolymers. Thermoplastic resin base compositions are especially preferred. UV absorbers, antioxidants and dispersing aids such as metal soaps may be added to the cover composition if necessary. The method of applying the cover is not critical. The cover is generally formed over the core by surrounding the core by a pair of preformed hemispherical cups followed by heat compression molding or by injection molding the cover composition over the core.

Like conventional golf balls, the three-piece solid golf ball of the invention is formed with a multiplicity of dimples in the cover surface. The golf ball of the invention is formed with dimples such that, provided that the golf ball is a sphere defining a phantom spherical surface, the proportion of the surface area of the phantom spherical surface delimited by the edge of respective dimples relative to the overall surface area of the phantom spherical surface, that is the percent occupation of the ball surface by the dimples is at least 62%, preferably 63 to 85%. With a dimple occupation of less than 62%, the above-mentioned flight performance, especially an increased flight distance is not expectable. The total number of dimples is preferably 360 to 450, more preferably 370 to 440. There may be two or more types of dimples which are different in diameter and/or depth. It is preferred that the dimples have a diameter of 2.2 to 4.5 mm and a depth of 0.12 to 0.23 mm. The arrangement of dimples may be selected from regular octahedral, dodecahedral, and icosahedral arrangements as in conventional golf balls while the pattern formed by thus arranged dimples may be any of square, hexagon, pentagon, and triangle patterns.

Moreover, the dimples are preferably formed such that V_0 is 0.39 to 0.6, especially 0.41 to 0.58 wherein V_0 is the volume of the dimple space below a plane circumscribed by the dimple edge divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom.

Now the shape of dimples is described in further detail. In the event that the planar shape of a dimple is circular, as shown in FIG. 2, a phantom sphere 6 having the ball diameter and another phantom sphere 7 having a diameter smaller by 0.16 mm than the ball diameter are drawn in

conjunction with a dimple 5. The circumference of the other sphere 7 intersects with the dimple 5 at a point 8. A tangent 9 at intersection 8 intersects with the phantom sphere 6 at a point 10 while a series of intersections 6 define a dimple edge 11. The dimple edge 11 is so defined for the reason that otherwise, the exact position of the dimple edge cannot be determined because the actual edge of the dimple 5 is rounded. The dimple edge 11 circumscribes a plane 12 (having a diameter Dm). Then as shown in FIGS. 3 and 4, the dimple space 13 located below the plane 12 has a volume Vp. A cylinder 14 whose bottom is the plane 12 and whose height is the maximum depth Dp of the dimple from the bottom or circular plane 12 has a volume Vq. The ratio V_0 of the dimple space volume Vp to the cylinder volume Vq is calculated.

$$Vp = \int_0^{\frac{Dm}{2}} 2\pi xy dx$$

$$Vq = \frac{\pi Dm^2 Dp}{4}$$

$$V_0 = \frac{Vp}{Vq}$$

In the event that the planar shape of a dimple is not circular, the maximum diameter or length of a dimple is determined, the plane projected shape of the dimple is assumed to be a circle having a diameter equal to this maximum diameter or length, and V_0 is calculated as above based on this assumption.

Furthermore, provided that the number of types of dimples formed in the ball surface is n wherein $n \geqq 2$, preferably n=2 to 6, more preferably n=3 to 5, and the respective types of dimples have a diameter Dmk, a maximum depth Dpk, and a number Nk wherein k=1, 2, 3, . . . , n, the golf ball of the invention prefers that an index Dst of overall dimple surface area given by the following equation (1) is at least 4, more preferably 4 to 8.

$$Dst = \frac{n \sum_{k=1}^{n} [(Dmk^2 + Dpk^2) \times V_{0k} \times Nk]}{4R^2} \quad (1)$$

Note that R is a ball radius, V_0 is as defined above, and Nk is the number of dimples k. The index Dst of overall dimple surface area is useful in optimizing various dimple parameters so as to allow the golf ball of the invention having the above-mentioned solid core and cover to travel a further distance. When the index Dst of overall dimple surface area is equal to or greater than 4, the aerodynamics (flying distance and flight-in-wind) of the golf ball are further enhanced.

While the three-piece solid golf ball of the invention is constructed as mentioned above, other ball parameters including weight and diameter are properly determined in accordance with the Rules of Golf.

The three-piece solid golf ball of the invention will travel an increased flight distance on full shots with a driver and be easy to control on approach shots with No. 5 iron or sand wedge.

EXAMPLE

Examples of the present invention are given below together with Comparative Examples by way of illustration and not by way of limitation. The amounts of components in the core, intermediate layer, and cover as reported in Tables 1 and 2 are all parts by weight.

Examples 1–5 and Comparative Examples 1–4

Solid cores, Nos. 1 to 6, were prepared by kneading components in the formulation shown in Table 1 to form a rubber composition and molding and vulcanizing it in a mold under conditions as shown in Table 1. The cores were measured for JIS-C hardness and diameter, with the results shown in Tables 3 and 4. The JIS-C hardness of the core was measured by cutting the core into halves, and measuring the hardness at the center (center hardness) and the hardness at core surface or spherical surface (surface hardness). The result is an average of five measurements.

TABLE 1

Core No.	1	2	3	4	5	6
Formulation						
Cis-1,4-poly-butadiene rubber	100	100	100	100	100	100
Zinc acrylate	24	24	25	29	15	34
Zinc oxide	29	26	34	27	33	25
Dicumyl peroxide	1	1	1	1	1	0
*1	0.3	0.3	0.3	0.3	0.3	1
Vulcanizing conditions						
Temperature, °C.	160	160	160	160	160	155
Time, min.	20	20	20	20	20	15
Core hardness*2, mm	3.7	3.7	3.5	3	5.7	2.2

*1 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane (trade name Perhexa 3M-40 manufactured by Nippon Oil and Fats K.K.)
*2 distortion under a load of 100 kg

Next, compositions for the intermediate layer and cover were milled as shown in Table 2 and injection molded over the solid core and the intermediate layer, respectively, obtaining three-piece solid golf balls as shown in Table 4. At the same time as injection molding, two or three types of dimples were indented in the cover surface as shown in Table 3. Whenever the intermediate layer and cover were molded, the intermediate layer and cover were measured for JIS-C hardness, specific gravity and gage. The results are also shown in Table 4.

TABLE 2

Intermediate layer and cover formulations (pbw)

	A	B	C	D	E
Himilan 1557*3	50	—	50	—	—
Himilan 1601*3	—	—	50	—	—
Himilan 1605*3	50	50	—	—	—
Himilan 1855*3	—	—	—	50	50
Himilan 1856*3	—	—	—	—	50
Himilan 1706*3	—	50	—	—	—
Surlyn 8120*4	—	—	—	50	—

*3 ionomer resin manufactured by Mitsui-duPont Polychemical K.K.
*4 ionomer resin manufactured by E.I. duPont of USA

TABLE 3

Dimple						
Dimple set	Diameter (mm)	Depth (mm)	V_0	Number	Dst	Surface occupation (%)
I	4.000	0.200	0.50	72	4.539	75
	3.850	0.193	0.50	200		
	3.400	0.170	0.50	120		
				total 392		
II	3.800	0.205	0.48	162	4.263	74
	3.600	0.194	0.48	86		
	3.450	0.186	0.48	162		
				total 410		
III	3.400	0.195	0.39	360	2.148	61
	2.450	0.195	0.39	140		
				total 500		

The thus obtained golf balls were evaluated for flight performance, spin, feel, spin control, and durability by the following tests.

Flight performance

Using a hitting machine manufactured by True Temper Co., the ball was actually hit with a driver (#W1) at a head speed of 45 m/s (HS45) and 35 m/sec. (HS35) to measure a spin, carry, and total distance.

Feel

Five golfers with a head speed of 45 m/sec. (HS45) and five golfers with a head speed of 35 m/sec. (HS35) actually hit the balls. The ball was rated according to the following criterion.

○:soft
Δ:ordinary
X:hard

Spin control

Three professional golfers actually hit the ball with No. 5 iron (#I5) to examine intentional hook and slice and stoppage on the green and also with a sand wedge (#SW) to examine spin on 30 and 80 yard shots (that is, stoppage on the green and ease of capture of the ball upon impact). An overall rating of the ball was derived from these spin control factors. The ball was rated "○" for easy control, "Δ" for ordinary, and "X" for difficult control.

Durability

Durability against continuous strikes and durability against cutting were evaluated in combination. The ball was rated according to the following criterion.

○:excellent
Δ:ordinary
X:inferior

TABLE 4

	Examples					Comparative Examples			
	1	2	3	4	5	1	2	3	4
Core									
Type	1	2	3	4	1	1	5	6	4
Center hardness A (JIS-C)	64	64	65	68	64	64	52	80	68
Surface hardness B (JIS-C)	75	75	77	82	75	75	62	90	82
B − A	11	11	12	14	11	11	10	10	14
Diameter (mm)	36.5	37.9	35.1	37.9	36.5	36.5	36.5	36.5	37.9
Intermediate layer									
Type	A	A	B	B	C	A	D	B	A
Hardness C (JIS-C)	86	86	93	93	83	86	75	93	86
C − B	11	11	16	11	8	11	13	3	4
Specific gravity	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Gage (mm)	1.6	1.2	1.8	1.2	1.6	1.6	1.6	1.6	1.8
Cover									
Type	E	E	C	F	D	E	B	A	B
Hardness D (JIS-C)	80	80	83	80	75	81	93	86	93
D − C	−6	−6	−10	−13	−8	−5	18	−7	7
Specific gravity	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Gage (mm)	1.5	1.5	2.0	1.5	1.5	1.5	1.5	3.5	2.0
Intermediate layer/cover combined gage (mm)	3.1	2.7	3.8	2.7	3.1	3.1	3.1	5.1	3.8
Dimple set	I	I	II	II	II	III	I	I	I
Ball outer diameter (mm)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
#W1/HS45									
Spin (rpm)	2800	2750	2900	2700	2950	2800	2650	2700	2680
Carry (m)	209.0	210.0	210.0	209.5	210.5	207.0	209.0	207.5	208.5
Total (m)	223.0	224.5	223.5	222.0	224.0	218.0	221.0	217.0	218.0
Feel	○	○	○	○	○	○	Δ	X	X
#W1/HS35									
Spin (rpm)	4600	4400	4650	4700	4750	4600	4600	4680	4630
Carry (m)	142.0	144.0	142.5	144.0	143.0	138.0	142.5	139.0	140.0
Total (m)	150.0	153.0	150.0	152.5	152.0	145.0	149.5	145.5	148.0
Feel	○	○	○	○	Δ	○	Δ	X	X
Spin control	○	○	○	○	○	○	X	Δ	X
Durability	○	○	○	○	○	○	X	Δ	Δ

Note:
A hardness difference is represented by (B − A), (C − B), and (D − C). (B − A) is equal to the core surface hardness minus the core center hardness; (C − B) is equal to the intermediate layer hardness minus the core surface hardness; and (D − C) is equal to the cover hardness minus the intermediate layer hardness.

As is evident from Table 4, the ball of Comparative Example 1 which is identical with the ball of Example 1 except for the dimple set is unsatisfactory in flight distance because the dimple surface occupation is as low as 61%. The ball of Comparative Example 2 is inferior in hitting feel, spin control, and durability since the cover is harder than the intermediate layer. The ball of Comparative Example 3 is unsatisfactory in flight distance and hitting feel because the core surface hardness and core center hardness are too high and the hardness difference between the intermediate layer and the core surface is too small. The ball of Comparative Example 4 is inferior in flight distance, hitting feel, and spin control since the cover is harder than the intermediate layer and the intermediate layer is insufficiently harder than the core.

In contrast, the golf balls of Examples 1 to 5 within the scope of the invention receive an appropriate spin rate upon full shots with a driver to travel a longer flight distance, are easy to spin control upon approach shots, and are excellent in both hitting feel and durability.

Japanese Patent Application No. 82121/1996 is incorporated herein by reference.

Although some preferred embodiments have been described, many modifications and variations may be made thereto in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. A three-piece solid golf ball of the three-layer structure comprising a solid core, an intermediate layer, and a cover, having a plurality of dimples in the ball surface wherein

the solid core, intermediate layer, and cover each have a hardness as measured by a JIS-C scale hardness meter wherein the core center hardness is up to 75 degrees, the core surface hardness is up to 85 degrees, the core surface hardness is higher than the core center hardness by 8 to 20 degrees, the intermediate layer hardness is higher than the core surface hardness by at least 5 degrees, and the cover hardness is lower than the intermediate layer hardness by at least 5 degrees, and

the dimples occupy at least 62% of the ball surface.

2. The three-piece solid golf ball of claim 1 wherein said intermediate layer has a gage of 0.2 to 3 mm and a specific gravity of 0.9 to less than 1.2.

3. The three-piece solid golf ball of claim 1 wherein said cover is based on a thermoplastic resin and has a hardness of up to 90 degrees as measured by the JIS-C scale hardness meter.

4. The three-piece solid golf ball of claim 1 wherein said cover has a gage of 0.2 to 3 mm and a specific gravity of 0.9 to less than 1.2.

5. The three-piece solid golf ball of claim 1 wherein said solid core is formed of a cis-1.4-polybutadiene base elastomer and has a diameter of 34 to 41 mm.

6. The three-piece solid golf ball of claim 1 wherein the dimples in the ball surface total in number to 360 to 450 and include at least two types of dimples having different diameters, and an index (Dst) of overall dimple surface area given by the following expression is at least 4.

$$Dst = \frac{n \sum_{k=1}^{n} \{(Dmk^2 + Dpk^2) x V_0 k x Nk\}}{4R^2}$$

wherein R is a ball radius, n is the number of dimple types (n≧2), Dmk is a diameter of dimples k. Dpk is a depth of dimples k. Nk is the number of dimples k wherein k=1, 2, 3, . . . n, and V_0, is the volume of the dimple space below a plane circumscribed by the dimple edge divided by the volume of a cylinder whose bottom is the plane and whose height is the maximum depth of the dimple from the bottom.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

Page 1 of 2

PATENT NO. : 5,782,707
DATED : July 21, 1998
INVENTOR(S) : Hisashi Yamagishi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Please add claims 7-17 as follows:

7. The three-piece solid golf ball of claim 6 wherein Dmk is in the range of 2.2 to 4.5 and Dpk is in the range of 0.12 to 0.23 mm.

8. The three-piece solid golf ball of claim 6 wherein V_0 is in the range of 0.39 to 0.6.

9. The three-piece solid golf ball of claim 1 wherein said core center hardness is in the range of 60 to 73 as measured on JIS-C.

10. The three-piece solid golf ball of claim 1 wherein said core has a surface hardness in the range of 70 to 83 degrees on JIS-C.

11. The three-piece solid golf ball of claim 1 wherein said core surface hardness is higher than the center hardness by 10 to 18 degrees.

12. The three-piece solid golf ball of claim 1 wherein said solid core has a distortion in the range of 2.5 to 4.5 mm under an applied load of 100 kg.

13. The three-piece solid golf ball of claim 1 wherein said intermediate layer has a hardness in the range of 75 to 100 degrees measured on JIS-C.

14 The three-piece solid golf ball of claim 1 wherein said intermediate layer has a hardness higher than the core surface hardness by t to 20 degrees.

15. The three-piece solid golf ball of claim 1 wherein said cover has a hardness in the range of 70 to 90 degrees measured on JIS-C.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

Page 2 of 2

PATENT NO. : 5,782,707
DATED : July 21, 1998
INVENTOR(S) : Hisashi Yamagishi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

16. The three-piece solid golf ball of claim 1 wherein the gage of the intermediate layer and the cover combined is in the range of 2 to 4.5 mm.

17. The three-piece solid golf ball of claim 1 wherein said dimples occupy 63 to 85% of the ball surface

Signed and Sealed this

Sixth Day of November, 2001

Attest:

Nicholas P. Godici

Attesting Officer

NICHOLAS P. GODICI
Acting Director of the United States Patent and Trademark Office

EXHIBIT 2

THIS EXHIBIT HAS BEEN REDACTED IN ITS ENTIRETY

EXHIBIT 3

IN UNITED STATES DISTRICT COURT
DISTRICT OF DELAWARE

BRIDGESTONE SPORTS CO., LTD., and BRIDGESTONE GOLF, INC., *Plaintiffs,* *v.* ACUSHNET COMPANY, *Defendant.*	C.A. No. 05-132(JJF) DEMAND FOR JURY TRIAL

EXPERT REPORT OF LARRY C. CADORNIGA

Submitted on February 20, 2007

CONTAINS HIGHLY CONFIDENTIAL INFORMATION
SUBJECT TO PROTECTIVE ORDER

IX. GRADIENTS

[162] Dr. Koenig discusses the concept of core gradients starting at paragraph 302. Particularly, at paragraph 306, Dr. Koenig states his understanding that, "As a consequence, the curing will begin at the surface immediately, but will not begin at the core until the core reaches a sufficiently high temperature to decompose its crosslinking agent." I disagree that this is the only situation that could occur when curing a core material.

[163] While it is true that the surface of the core material closest to the mold will be directly exposed to longer curing times and to higher curing temperatures, particularly using the sulfur vulcanizing system, it is not necessarily true that there will also exist a gradient in hardness from the core to the surface.

[164] Based on my more than thirty years of hands-on rubber molding experience, it is my opinion that large variances in hardness readings or high degrees of differences in hardness readings within a rubber article such as golf ball cores is unwelcome and reflects poor quality of manufacture. Almost all rubber articles conform to requirements (which is the definition of "quality") based on hardness consistencies within specified tolerances.

[165] The discovery and invention of the gradient hardness in a golf ball core was found to be beneficial to enhance the performance qualities of golf balls as to: feel, spin, control on specific shots, resilience and durability.

[166] Dr. Koenig's statement that "for a golf ball, there will always be a gradient in hardness and other physical and mechanical properties from the core to the surface with the surface being higher" is not technically correct. This may be mostly true with respect to typical rubber articles but not necessarily true with solid golf ball cores:

EXHIBIT 4

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

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------------------------------x
BRIDGESTONE SPORTS CO. LTD., :
and BRIDGESTONE GOLF, INC.,  :
                             :
            Plaintiff,       :
                             :  Civil Action No.
      vs.                    :      05-132
                             :
ACUSHNET COMPANY,            :
                             :
            Defendant.       :
------------------------------x
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Washington, D.C.

Thursday, March 15, 2007

Videotape Deposition of:

JOHN CALABRIA,

the witness, was called for examination by counsel for the Defendant, pursuant to notice, commencing at 9:32 a.m., at the law offices of Howrey LLP, 1299 Pennsylvania Avenue, Northwest, Washington, D.C., before Dawn A. Jaques, Certified Shorthand Reporter and Notary Public in and for the District of Columbia, when were present on behalf of the respective parties:

DIGITAL EVIDENCE GROUP
1111 16th Street, NW Suite 410
Washington, DC 20036
(202) 232-0646

A Personal experience, no.

Q Yeah, okay. Other than your understanding of this exothermic reaction, do you have any other basis for your statement that cores do not always cure from the outside inward?

A Well, understanding core chemistry and working with rubber chemists.

Q Okay. Is there anything specific about your experience that you're drawing on here?

A It's -- when I worked at Dunlop, we did a lot of development of cores, and so working with the rubber chemists that reported to me, I would gain an understanding of core chemistry, the processes used to manufacture cores, what the limitations were, things like that.

Q Okay. Do you agree that cores generally cure from the outside inward?

A There are a lot of parameters that would have to be known to really understand that completely.

Q Okay. Is it accurate to say that you can't say as a general rule that cores generally

because if you have a low pressure, the conduction may be slower. If you have higher pressure, the conduction may be faster.

It also will depend on the size of the core.

Q Why does it depend on the size of the core?

A Smaller cores would conduct heat a little bit easier than larger cores.

Q Let me just go back to pressure because there's one other thing I want to understand about your opinion.

It's your understanding -- in order to make a golf ball, you have to supply enough pressure to the mold to keep it closed, correct?

A Yes, sir.

Q Okay. What I don't understand about -- strike that.

As long as you apply enough pressure to keep the mold closed, does the amount or the total amount of the pressure affect your opinion, provided there's at least enough pressure to keep

mold?

A It's the word I used.

Q Okay. We'll be communicating?

A Yes, sir.

Q Okay. Do you have an opinion about whether bumping the mold affects the core gradient of the core that's being molded?

A My opinion would be that if it's brief and closes again, then probably not.

Q Okay. All right. Now let me continue down your list.

You said that the geometry of the mold or the number of cavities could affect the core gradient; is that correct?

A I believe that's true, yes.

Q In what respect or what impact does the geometry of the mold have on the core gradients, in your opinion?

A Depends on how close the cavities are to each other, how many cavities are in a platen, how you're heating them, so it would help understand the spaces between the cavities, so how well are

you conducting heat to the cavities.

Also typically, depending on the size of the platen, some of the cavities on the edges might see less heat than cavities in the middle. And, again, you're dealing with an exothermic reaction, so it's -- potentially you might get more heat in the middle where you have a mass of -- metal and a mass of cores is concerned -- as compared to the outside.

Q Okay. Anything else on the geometry?

A No, I mentioned size.

Q Size. You did already tell me size --

A Yes.

Q -- and you told me the number of cavities.

A The number of cavities, arrangement on the platen, overall size of the platen, so how many cavities are on that platen, because you're going to get different properties if you have a 12-cavity mold versus a 120-cavity mold, for instance. I think that's possible.

Q How do you -- strike that.

In your opinion, why might the core gradient depend upon the number of cavities in the mold?

A Because of the way the heat is conducted --

Q Okay.

A -- to the core itself.

Q So depending upon how you apply the heat and the pressure, the number of cavities could affect the gradient depending upon how the heat's conducted across the mold --

A Correct.

Q -- is that what you're saying? I understand.

Just going back to the pressure for a second, have you personally investigated the effect of mold pressure on core gradients?

A I have not.

Q Okay. What is the basis for your opinions that pressure will or could affect the core gradient?

A Experience working in the industry.

A Okay.

Q You say that "This mixing operation, including sequencing of materials, time parameters and temperature profiles, can affect the rate of curing of the core when heated and, therefore, the resultant hardness gradient."

Do you see that?

A I do.

Q What is the -- well, first of all, what is the basis for your understanding there?

A My experience in the industry.

Q Okay. Let me just see if we're communicating first.

It's my understanding that the core components are mixed at a temperature below the peroxide initiation temperature or the temperature where the peroxide starts to generate free radicals.

Is that your understanding?

A I think it's a fair description. It's the matter of how they're mixed.

Q Okay. But do you agree with the sort of

general principle that the mixing is typically done below the peroxide initiation temperature?

A You're trying not to kick off the reaction.

Q Exactly. Do you agree with that in general?

A I do.

Q Okay. Given that that's the case, I'm trying to understand why the manner of mixing matters to your opinion.

A Because you can't completely avoid it. The heat that's generated in the process will start to cure, which is why the material has to be used in a certain period of time.

Q Okay. It's -- my understanding is that good manufacturing processes would dictate that you use the core within a fairly short amount of time after you make it so that there isn't a lot of cross-linking before you get in the mold; is that your understanding?

A Well, you said --

MR. CREMEN: Objection, vague.

THE WITNESS: You said core. There's a different -- there's an intermediate step that you need to worry about.

BY MR. LAVELLE:

Q Okay. Go ahead.

A So when you --

Q You're punching out these blobs?

A The -- we call them plugs --

Q Plugs.

A -- or preforms --

Q Okay.

A -- or whatever you want to call them, and those are the ones that you have to use up in a certain period of time.

Q Okay.

A Otherwise, they will cure.

Q Okay, yeah, I guess what I'm trying to get at is if you mix the chemicals and punch out these plugs, these sort of pencil eraser-shaped objects, and mold them in accord with good manufacturing processes, will the manner in which you mix the ingredients matter in any material way

to the finish core and its hardness --

MR. CREMEN: Objection --

BY MR. LAVELLE:

Q -- profile?

MR. CREMEN: Objection, vague.

THE WITNESS: Yes, I think it will --

BY MR. LAVELLE:

Q It will.

A -- on the back end. Of what you're doing on the back end could have an effect on the front end.

Q Could you explain what you mean by that?

A It depends on the process you're using.

Q What are the "front end" and the "back end" would be a start.

A Okay. You can mix core material either on a unit called a Banbury or you can do it on a mill.

Q Okay.

A Okay? Do you want me to describe those?

Q I -- why don't you go --

A Do you understand?

Q I think I know what a Banbury mixer
is --
A Okay.
Q -- and I can envision what a mill is.
A A Banbury is nothing but a big
Mixmaster.
Q Mixmaster, right. It's a blender in
your kitchen, right?
A Yeah, it's a blender.
A mill is what you use to make pasta --
Q Right.
A -- where you squeeze things out.
So you can do it one of two ways. You
can put your materials in the Banbury and start
loading in a certain sequence, and that sequence
is important because if you put materials in at
the wrong time, you will not get the curing or the
properties.
And the same thing would apply to a
mill. You need to put the material on the mill to
be able to accept the other chemicals that you're
adding to it.

Now, a mill and a Banbury are going to do different things to the core material in terms of the amount of time you're kneading, the amount of time you're mixing, the pressures you're applying, the temperatures you allow it to rise up to because some of these -- I think these machines are water-cooled to keep the temperature down to go back to your reference of preventing the peroxide from kicking off, okay?

So you're doing it either way. At some point, you have a sheet of material. That sheet of material now needs to be formed into your plug, and that's done through an extrusion process.

Q Okay.

A And that's adding heat again, so you have to be careful with that. There's no way to avoid it, and at some point you will have initiated the reaction.

So you extrude those plugs, you put them in a tray, you dust them so they don't stick together, and you have a limited amount of time to process them. And depending on where you catch

them in that cycle could determine what those properties are.

So to use your words, "good manufacturing practices," you try to be consistent as you move down the process.

Q Okay. And in that description, what's the -- what's the "front end" and what's the "back end"?

A Back end is the mixing and extruding. Front end is core molding.

Q Okay. Very good. And it's your opinion that if you follow what I'm calling good manufacturing practices, trying to minimize the amount of polymerization that occurs before you get the plug in the mold, will the order in which you mix still matter?

A Yes.

Q It will? Okay.

A Sorry.

Q He wants to object because it's asked and answered.

So if you wanted to know -- is it your

opinion that if you wanted to figure out if this EP 043 reference would have a core gradient within the 8 to 20 range of the '707 patent, you would need to know the details of the mixing operation as well?

A That would be helpful, yes.

Q Okay. Would you go up to Paragraph 47?

Do you see there's a discussion of some cores that Mr. Higuchi made?

A Yes.

Q Okay. And were you present at any of these experiments?

A I was not.

Q Okay. And the results were reported to you?

A Yes.

Q Okay. And in what fashion did you get the results of these?

A I think it was a spreadsheet.

Q Spreadsheet? And what data was on the spreadsheet, if you recall?

A Well, the formula was on there, the --

EXHIBIT 5

THIS EXHIBIT HAS BEEN REDACTED IN ITS ENTIRETY

EXHIBIT 6

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

- - - - - - - - - - - - - - - - -x

BRIDGESTONE SPORTS CO., LTD., :

And BRIDGESTONE GOLF, INC., :

Plaintiffs, :

v. : C.A. NO. 05-132 (JJF)

ACUSHNET COMPANY, :

Defendant. :

- - - - - - - - - - - - - - - - -x

ACUSHNET COMPANY, :

Counterclaim Plaintiffs, :

v. : C.A. NO. 05-132 (JJF)

BRIDGESTONE SPORTS CO., LTD., :

And BRIDGESTONE GOLF, INC., :

Counterclaim Defendant. :

- - - - - - - - - - - - - - - - -x

HIGHLY CONFIDENTIAL

Videotaped Deposition of LARRY CADORNIGA

Washington, D.C.

Monday, March 12, 2007

9:00 A.M.

DIGITAL EVIDENCE GROUP

1111 16th Street, NW Suite 410

Washington, DC 20036

(202) 232-0646

Q Are you an expert in statistics?
A No, I can't say I am, I don't have any of the studies in statistics.
Q And did you have a chance to read Cliff Sutton's expert report?
A To do what?
Q To read the expert report of Cliff Sutton?
A Yes, I did.
Q Do you have an opinion as to whether Cliff Sutton is an expert in statistics?
A I believe he is.
Q Have you read the expert report of Dr. Coughlin?
A Yes, I did.
Q And you're aware that he offers an opinion with respect to the `961 patent?
A Yes, I did.
Q Since you've been on the case for a long time did you ever initially have any involvement with respect to the `961 patent?
A Just through the reporting and all the proceedings that would involve proving that is

gradient.

Q Yes, sir, but beyond what you argue here is it or is it not your opinion that you cannot assume what the hardness is at an internal point of the core relative to the surface of the core without testing that particular point.

A Yeah, I -- yeah, I would agree with that statement, that I cannot assume, unless I have already established that during my development system, then I would assume and be comfortable that's what I'm getting.

Q If you establish that; correct?

A If I establish that.

MR. DUBIANSKY: Okay. Excuse me, I'd like -- I'd like to mark the following document, please.

(Cadorniga Exhibit No. 9 was marked for identification.

BY MR. DUBIANSKY:

Q Mr. Cadorniga, I'm now going to show you an exhibit marked No. 9, and the title of this exhibit is expert report of John Calabria, and it's my understanding this report was submitted on the 20th of

present?

A Without?

Q Without a lawyer present?

A I don't think I have, I think there's always a lawyer.

Q Did anybody from Bridgestone ever participate in these discussions?

A No.

Q Have you ever consulted with anyone from Bridgestone regarding this protocol?

A No.

Q Are your answers different for the other protocols contained in Dr. Caulfield's expert report?

A Are my answers different?

Q We have been speaking specifically with regard to Exhibit No. 9?

A Yeah, yeah, it will not be different, it will be the same.

Q It will be the same?

A Yeah.

Q When was the first testing in accordance with this protocol performed?

A If it's happening to me I would expect, you know, it's happening to other people, also, and they would attribute to that, I believe most people who would run this test would tell you the same thing.

Q But to be clear, sir, your opinion is that the literal scope of this claim may reach so far as 22 degrees, and the basis for that opinion is the fact that your own personal experience in performing this test has shown you as much?

A Yes.

Q Do you have any other basis for that opinion?

A No.

Q Okay. Returning back to page six of your expert report, sir?

A Which one, then?

Q Page six of your expert report, it's what --

A It's where I am right now, right.

Q When you wrote this report what was the basis for your -- your opinion that the number of samples was more than sufficient to comprise a

statistic --

A I was just basing it on the collective number of balls that we have tested and cut, not at one point -- not, you know, individual count for it, so that's the way I have dealt with it.

Q But did you perform any sort of analysis to render that opinion?

A Not personal analysis, I just -- I just, you know, thought that the number of the -- all the golf balls that have been tested is sufficient enough to establish significance.

Q And at the -- at the time when you formulated that opinion were you aware of the exact number of golf balls that was tested?

A I know there's a lot of balls tested. I don't have a complete count of all the combined accused golf balls that have been tested.

Q But you later -- strike that -- but at the time that you wrote these words and formulated this -- strike that -- at the time that you formulated this opinion you did not specifically know that only five golf balls were tested for core hardness for the `707

patent?

A Yeah, I was -- yeah, I was just aware after I was cross checking and reviewing it.

Q And --

A But still I think I had enough numbers collectively to call it significance of the test.

Q And after you learned that fact you then changed your opinion regarding whether or not that was a statistically significant sample; correct?

A Well, I still think that there's enough merit to call it a significant.

Q Statistically significant?

A Statistically significant.

Q And what's your basis for that?

A Just the results showing me all of it in the -- the parameters of it.

Q But beyond examining the results do you have any other basis for saying --

A No, I told you, already, I already asked that -- answered that question, I believe.

Q I don't believe you answered exactly that question, sir.

completed the world class statistical thinking for industry course at the Tri-County State College in Anderson, South Carolina?

MR. SHIN: Counsel, I -- I object, we've covered Mr. Cadorniga's CV based upon the earlier deposition questions. You are retreading over old ground.

MR. DUBIANSKY: I'll take that under advisement.

BY MR. DUBIANSKY:

Q Beyond this course did you have -- ever receive any other training in statistics?

A This is all I have that is written here.

Q And what was the nature of this course?

A I'm not sure, now, because it's been so long. But, you know, it refers to manufacturing, mostly, this is world class manufacturing concept, and world class statistical thinking for industry. So it may not refer to numbers, in particular.

Q Just general concepts?

A General concepts.

Q And how many credit hours was that class?

A I don't remember, this is probably a two-week course of some sort.

Q Two weeks, full time?

A No, I'm working.

Q Yes.

A I was working.

Q And who was the instructor, do you recall?

A I don't recall.

Q Was it a professor?

A It was a teacher of some sort.

Q And when did you take this class?

A During my Maxfli years, between `89, `91.

Q And have you ever, in your career, before, performed testing in order to characterize the properties of an entire production run of golf balls?

A Yes, I have.

Q How many times?

A Well, many times, when we did evaluation trial run, prototype run, a thousand this, and three thousand and five thousand thus and run.

Q What was the largest number of golf balls that you tried to characterize in such a study?

A Oh, as small as two dozen balls for testing.

Q But how many balls, 5,000, a million, ten million?

A Oh, no, I told you, it's as small as two dozen balls. Are you talking about the larger amount?

Q The larger amount, yes.

A Oh, I don't know. The most trial run for research and development would be about a thousand.

Q And that's about the biggest that you've done before?

A Yeah, that's at the R an D lab. When you go to manufacturing run it will be greater than that, but that will involve mostly a combined effort between research and development and manufacturing.

Q Yes, thank you. And for the purposes of performing testing for the patents that we're discussing this afternoon was there a random sampling plan or any sort of sampling plan in place to govern the matter in which balls were collected for a testing?

A Yeah, there will be a random plan. You

can't test all a thousand dozen.

Q And what was the plan?

A Just random samplings, pick two dozen balls from middle of the run or the first start of the run, middle of the run or the end of the run.

Q Because that's the best way to do it?

A That's the standard process that would develop.

Q I see. But for the purpose of your work in preparing these reports, here?

A Mm-hmm.

Q What plan did you create or utilize to govern the selection of golf balls?

A To govern the --

Q Selection of golf balls you were testing?

A The selection? I think the best we were able to do is we bought a dozen here and there, a dozen in California, a dozen in Florida, you know, a dozen in Chicago, and all that, and so I combine all the balls that way.

Q And did you buy all these balls around the same time or did you make an effort to buy balls from

Q Now, specifically with regard to the P2 balls, the five balls that were tested for the Pro V1 and the `707 patent, those balls are no longer on the market; right?

A Right, and I think that's the reason why, you know, the sample -- the sample is so small, is because there's nothing available for us to get.

Q Of course, it's hard for you to get the balls. Where did you get those balls from?

A I'm not sure, now, where we got those balls.

Q Who was --

A Dr. Caulfield will be here and be deposed sometime, and you may pose him the same question.

Q So was Dr. Caulfield in charge of obtaining the balls?

A Him and Kevin Jones, technically speaking, Packer, in this field, Packer Company was doing it.

Q And did Dr. Caulfield was he in charge of getting the P2 balls?

A Well, he's in charge of acquiring all the test balls, basically. I believe -- I don't know the

A Okay, I'm through.
Q Okay. Did you write these words, yourself?
A Part of it, yes, I did, and -- part of it I did summarize together with the assistance of the lawyers.
Q Anybody in particular?
A Terry Wikberg.
Q I see. I'd like to direct your attention to the very last paragraph contained within section G?
A Okay.
Q It's one sentence long, and the sentence reads: Therefore, it is my opinion that the accused Pro V1 golf balls literally have a core surface hardness that is higher than the hardness of the center of the core by eight to 20 degrees JIS-C?
A Okay, it's just stating here in the chart that there's a 19.5 difference between the center and the surface.
Q And that's your basis for formulating this opinion?
A Yes.
Q Do you have any other bases for formulating

that opinion?

A That's the only bases I have, and we have asterisk in there that we actually did not have this, but the data were provided by the depositions by the Acushnet documents, so this would be Acushnet documents.

Q And to be clear, sir, is it currently your opinion that the accused Pro V1 golf balls literally have a core surface hardness that is higher than the hardness at the center of the core by eight to twenty degrees JIS-C?

A According to this data, we have a core surface hardness of 82.8 subtracting 63.3 from the center, gives us a 19.5 difference.

Q And is it therefore your opinion that all of the accused Pro V1 golf balls literally have a core surface hardness that is higher than the hardness at the center of the core by eight to twenty degrees JIS-C?

A Yes.

Q And beyond the table E4 you have no other bases for that opinion?

A No other bases, that's the only one we have.

Q And you base your opinion on the fact that the difference reported in table E4, which is 19.5, is less than 20?

A Yes.

Q Thank you. Will you please -- actually, I've got one other question regarding this part of your report, sir -- you see that there is the paragraph with the asterisk, on page E9, yes?

A Yes.

Q And in that paragraph you state the opinion that the Pro V1-392, and Pro V1-392 stretched golf balls possessed the same difference in hardness between the core center and the core surface as the arrow Pro V1.392 arrow golf ball; correct?

A Right, correct.

Q And your basis for formulating that opinion is given in footnote 15; correct?

A Yes.

Q Do you have any other basis for forming that opinion?

EXHIBIT 7

THIS EXHIBIT HAS BEEN REDACTED IN ITS ENTIRETY

EXHIBIT 8

THIS EXHIBIT HAS BEEN REDACTED IN ITS ENTIRETY